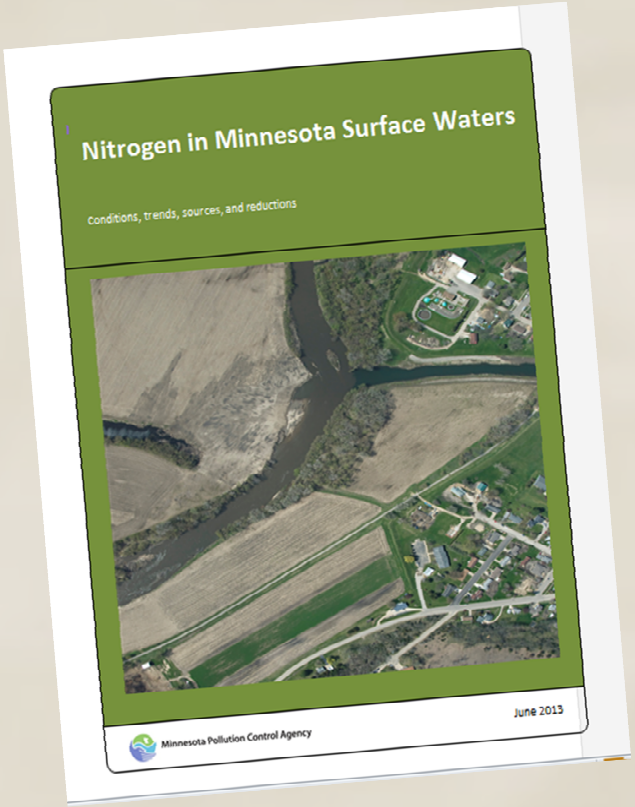
Nitrogen
in Minnesota Rivers
Conditions · Sources · Trends · Reductions



- Minnesota Pollution Control Agency
  David Wall, Steve Weiss, Dennis Wasley, Thomas Pearson, David Christopherson, Bruce Henningsgaard, Nick Gervino, Pat Baskfield
- University of Minnesota
  David Mulla, William Lazarus, Karina Fabrizzi, Jacob Galzki, Ki-In Kim, Mae Davenport, Bjorn Olson, Geoffrie Kramer
- U.S. Geological Survey
  David Lorenz, Gary Martin, Dale Robertson, David Saad

Minnesota Pollution Control Agency

CLEAN WATER LAND & LEGACY AMENDMENT

Concerns about nitrogen in MN surface waters

Minnesota waters

Aquatic life toxicity

- MPCA developing standards

Drinking water in streams

- 15 streams exceed cold water standard of 10 mg/l

Downstream waters

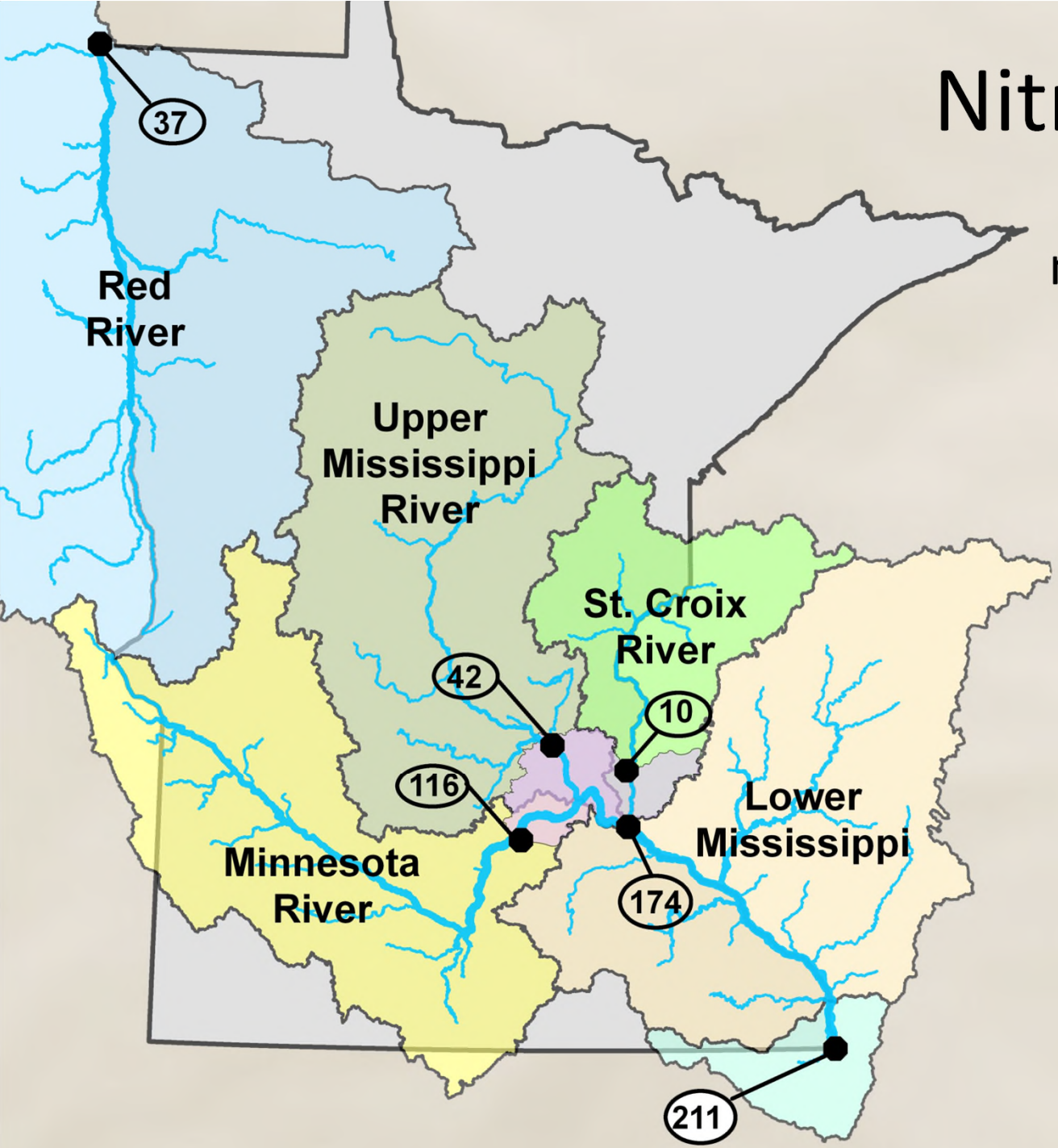
Gulf of Mexico - hypoxia

Lake Winnipeg – algae blooms

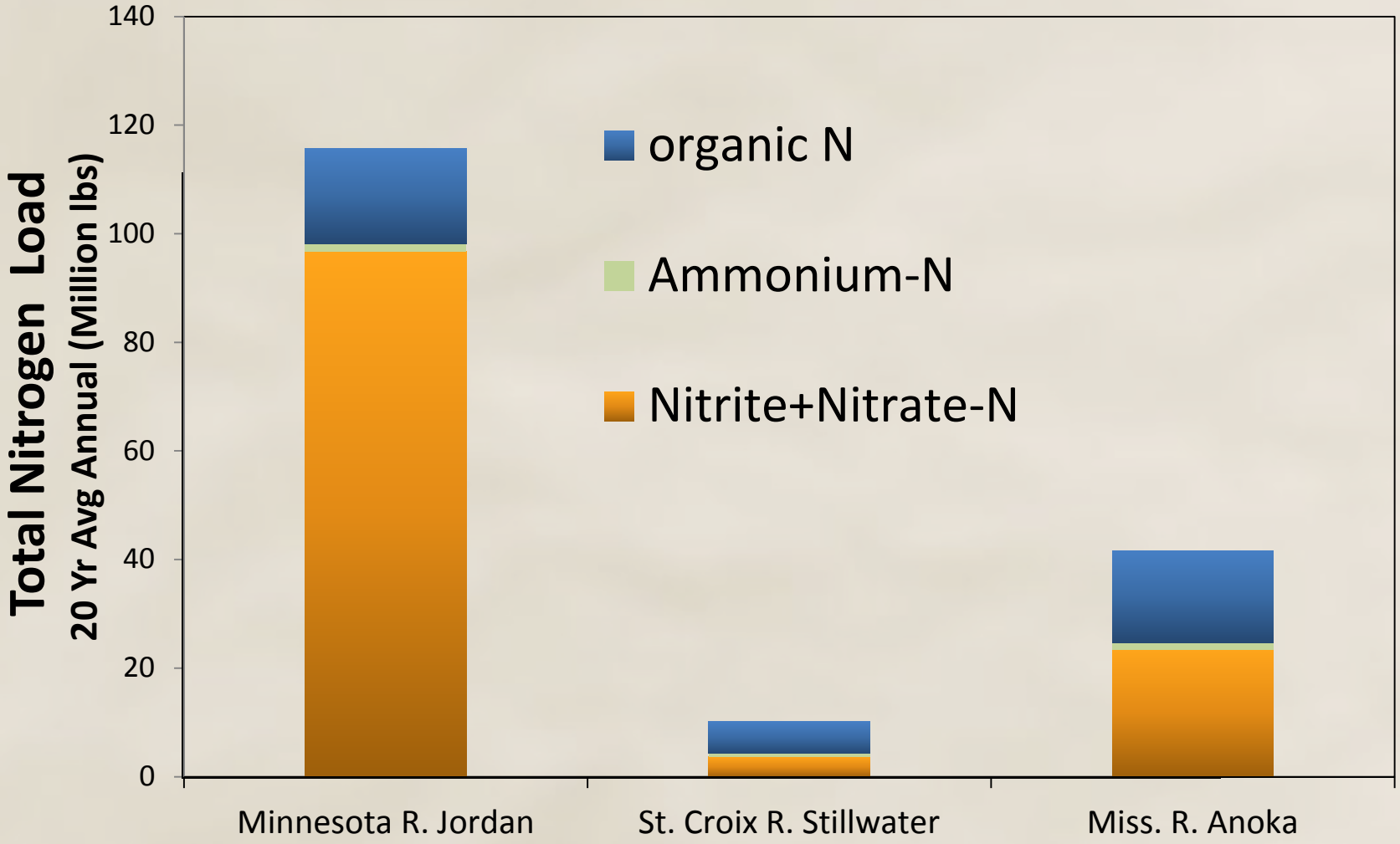
Iowa Rivers – drinking water

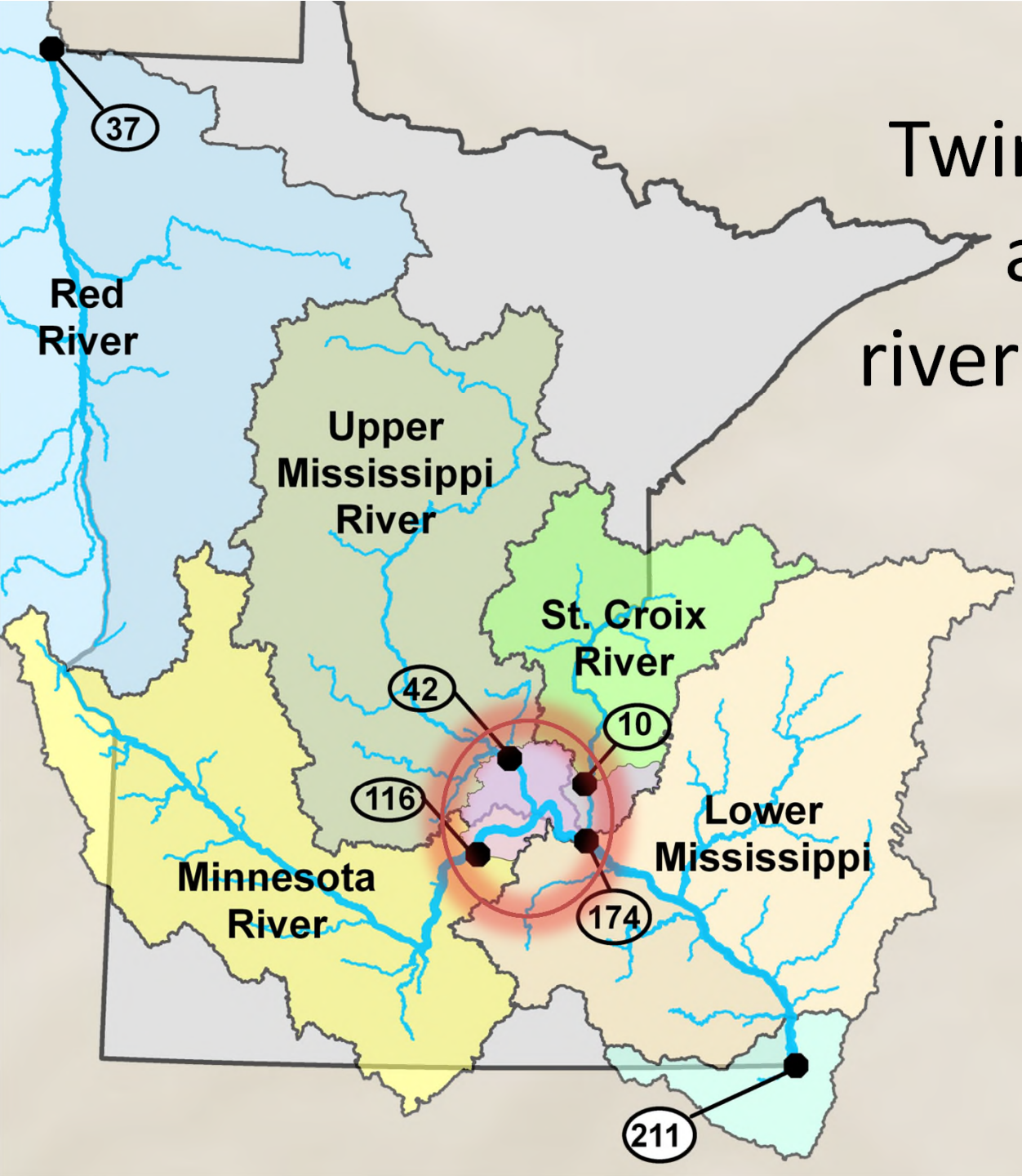
Nitrogen Loads

long-term average
million lbs per year

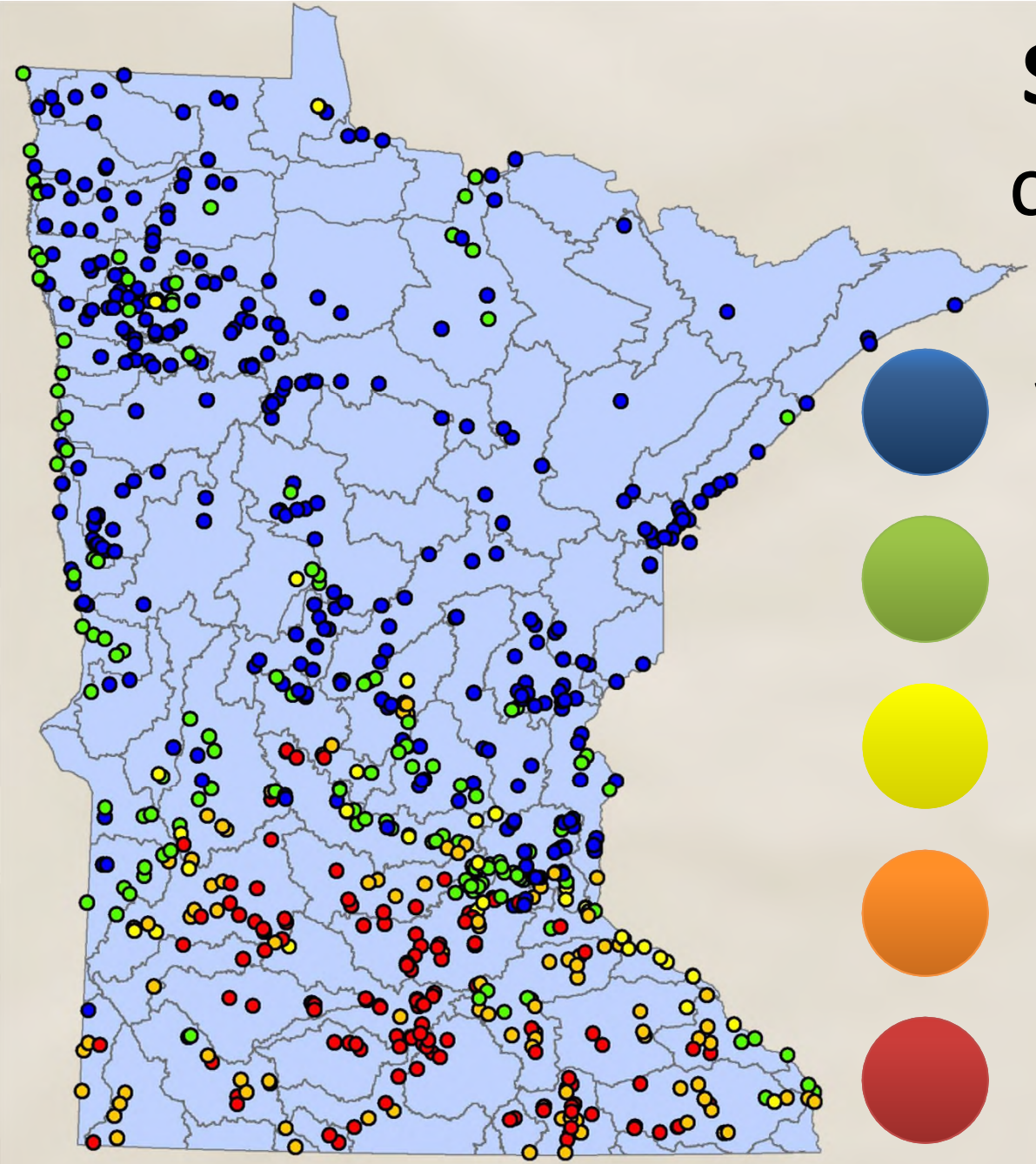


Nitrate is dominant form in high-nitrogen rivers





Twin Cities region added 3.5% to river nitrogen load



Stream nitrate concentrations

(90th Percentiles 2000-2010)

Very low: <1 mg/L

Low: 1-3

Medium: 3-5

High: 5-10

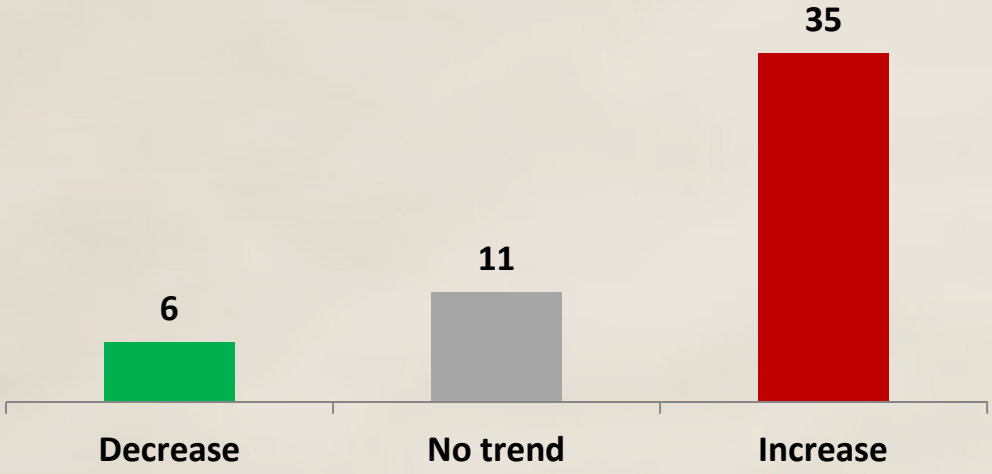
Exceeds 10 mg/L

Nitrate Concentrations

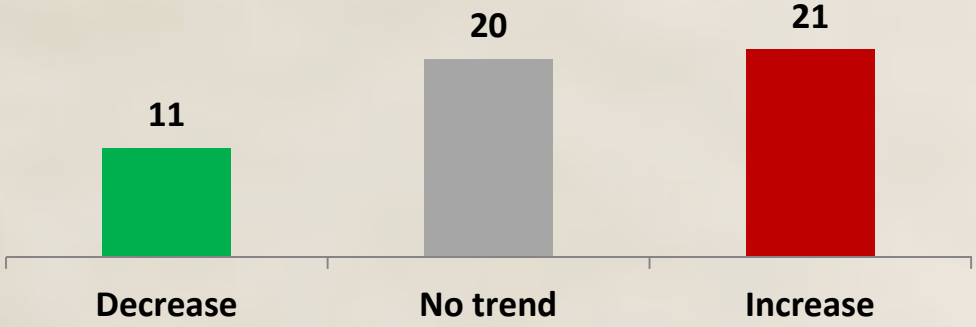
Flow Adjusted
QWTREND

- Increase
- Decrease
- No trend

1976 to 2010
52 River Monitoring Sites

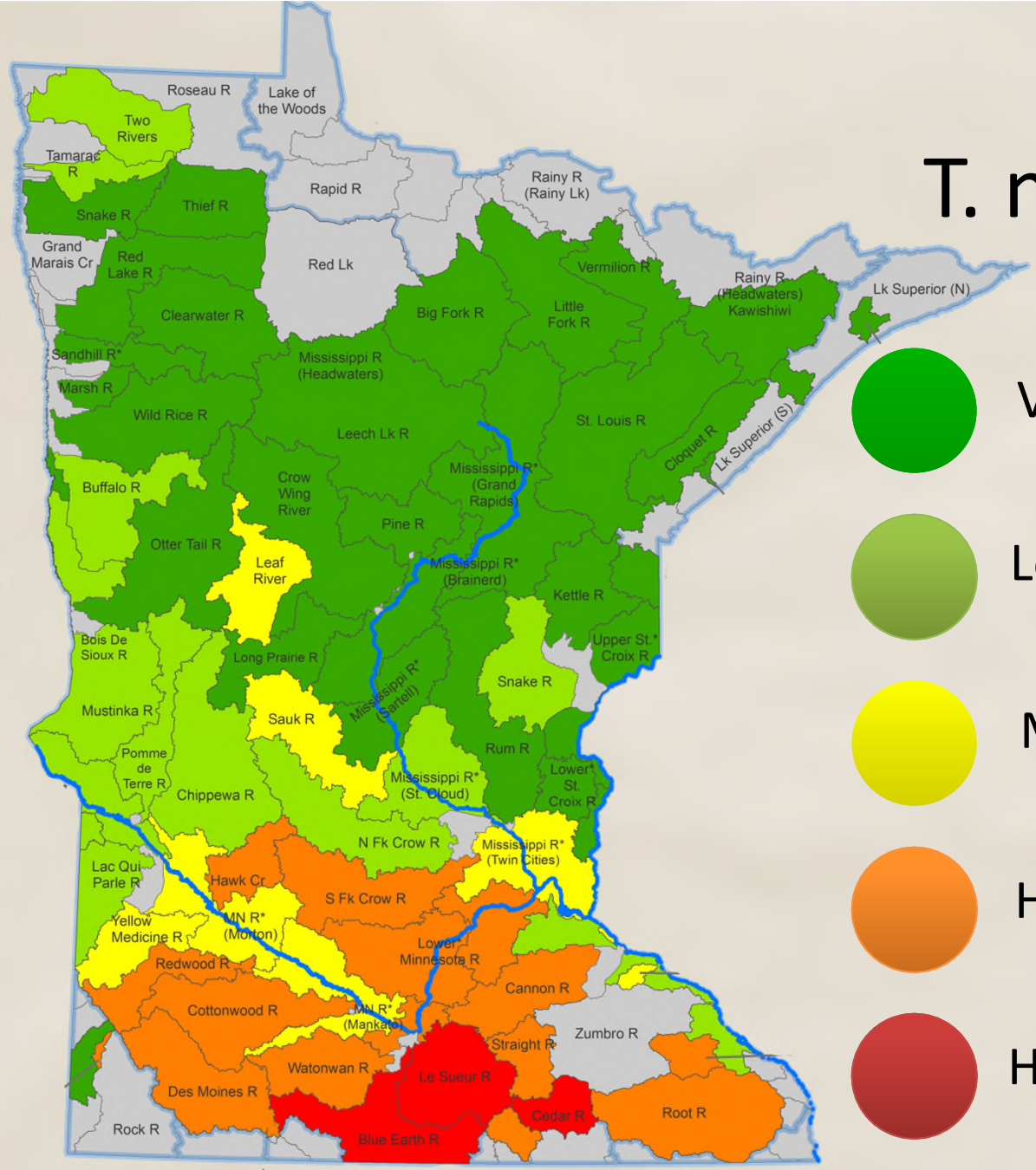


Recent Trends
52 River Monitoring Sites



Watershed T. nitrogen yields

(2007-2009 monitoring)



Very low <2.3 lbs/ac/yr

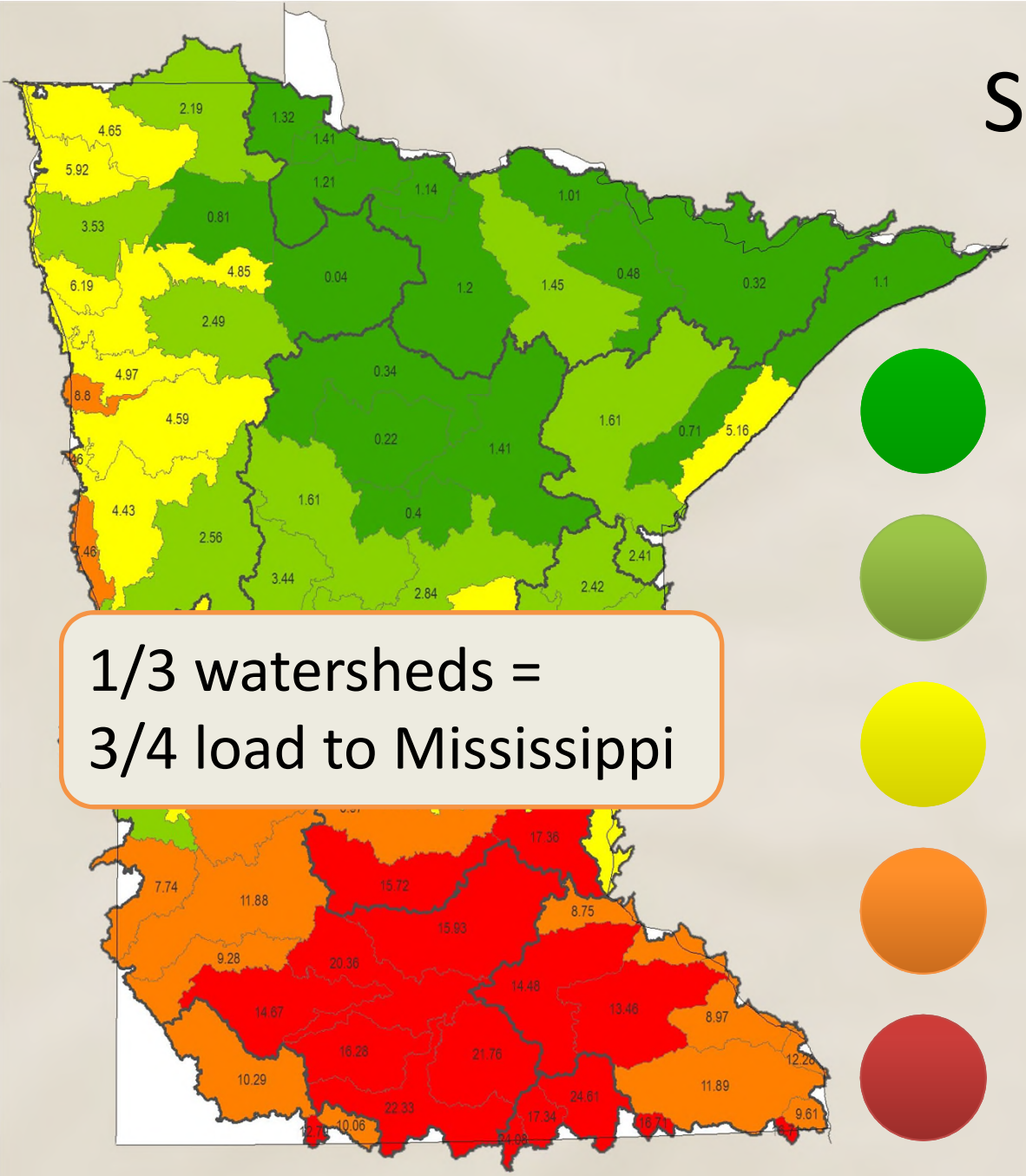
Low 2.3 - 3.3

Medium 3.3 - 5

High 5 - 12

Highest 12+ lbs/ac/yr

SPARROW model nitrogen yield



1/3 watersheds =
3/4 load to Mississippi

- Very Low <1.5 lb/ac/yr
- Low: 1.5-3.4
- Medium: 3.5 – 6
- High: 6-12
- Highest: 12-25 lb/ac/yr

Nitrogen Sources

Cropland groundwater

Cropland tile drainage

Cropland runoff

Domestic wastewater

Industrial wastewater

Urban stormwater

Septic systems

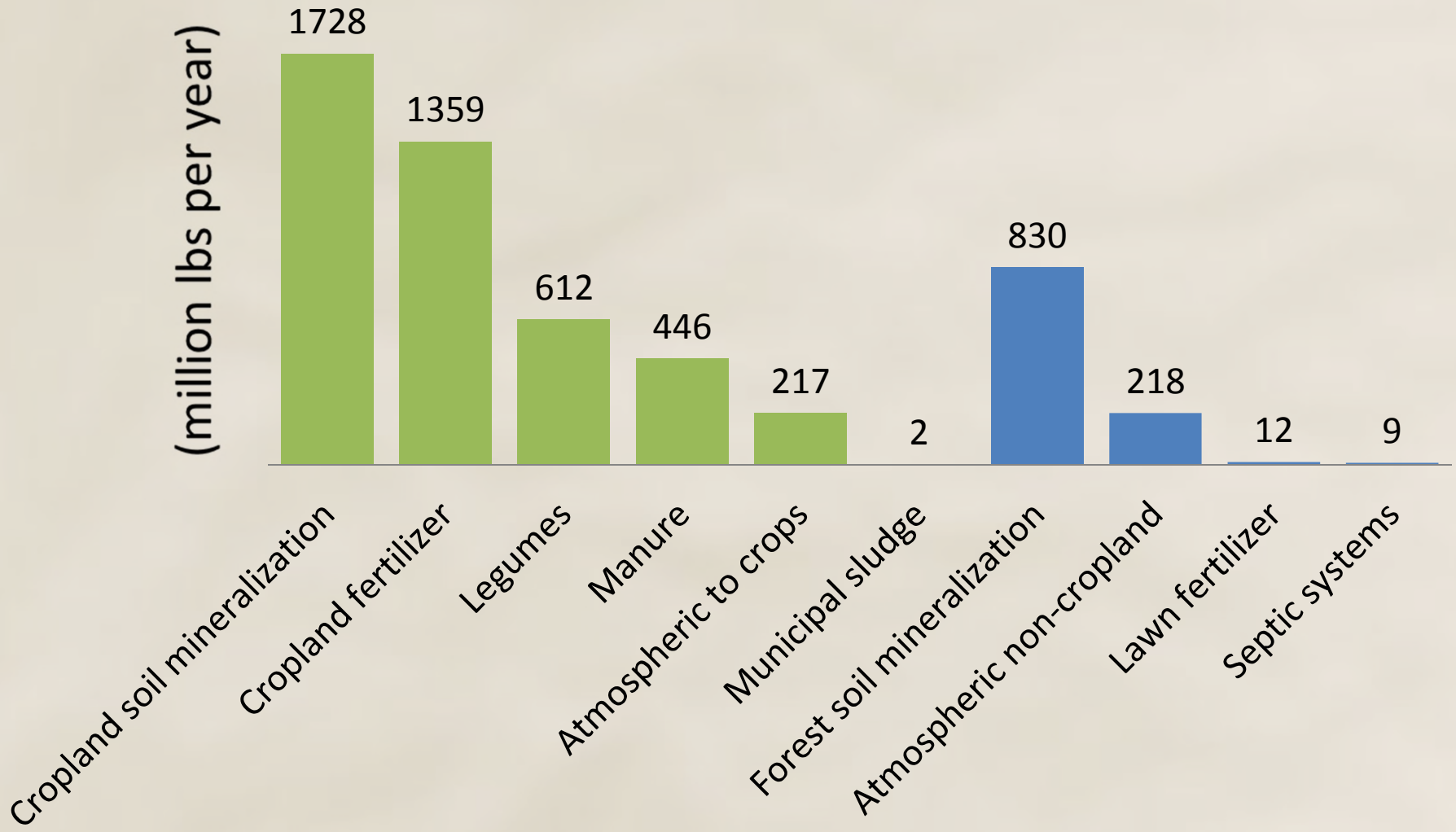
Forests

Atmospheric deposition

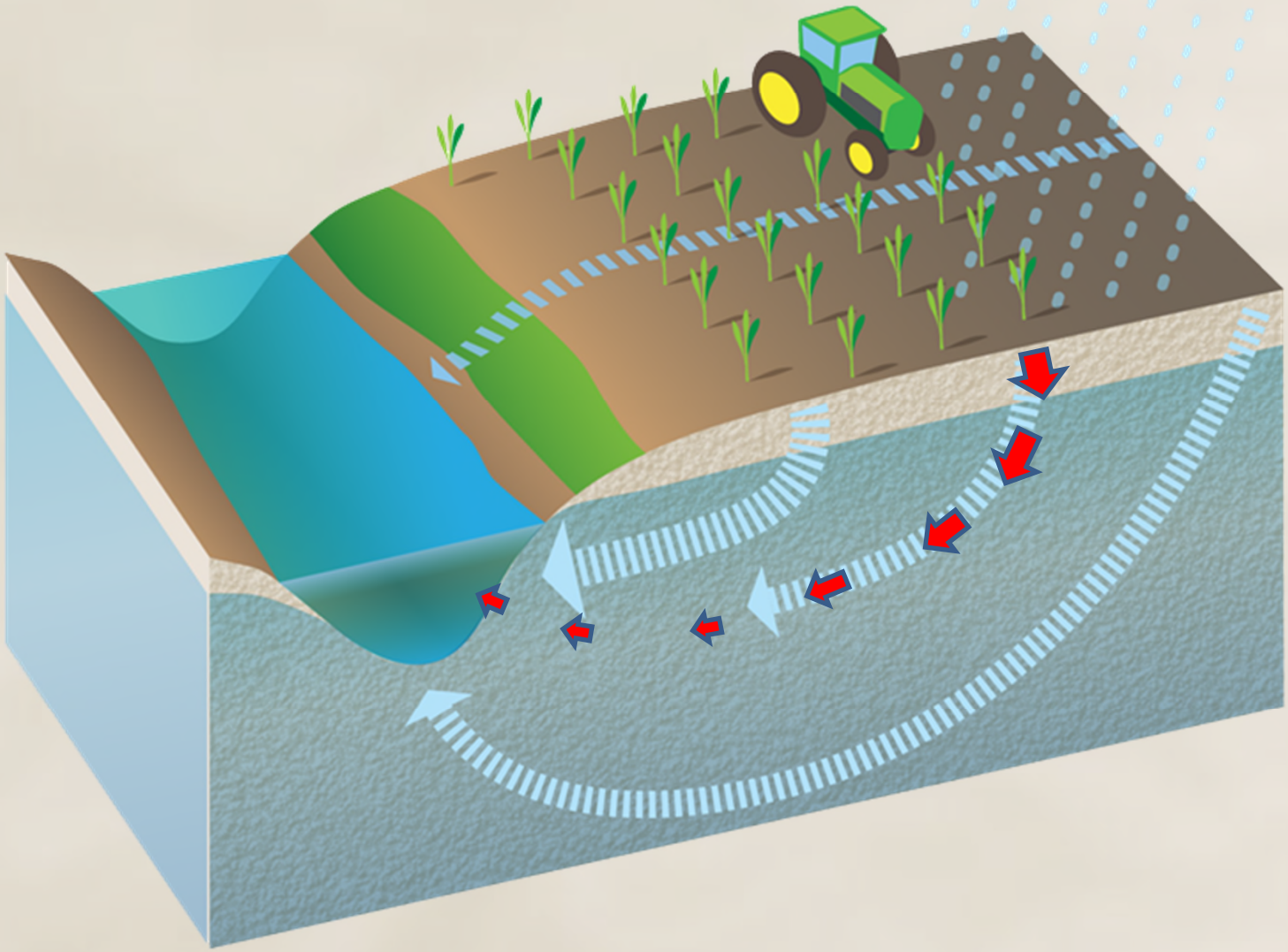
Barnyard runoff

Sources to soils

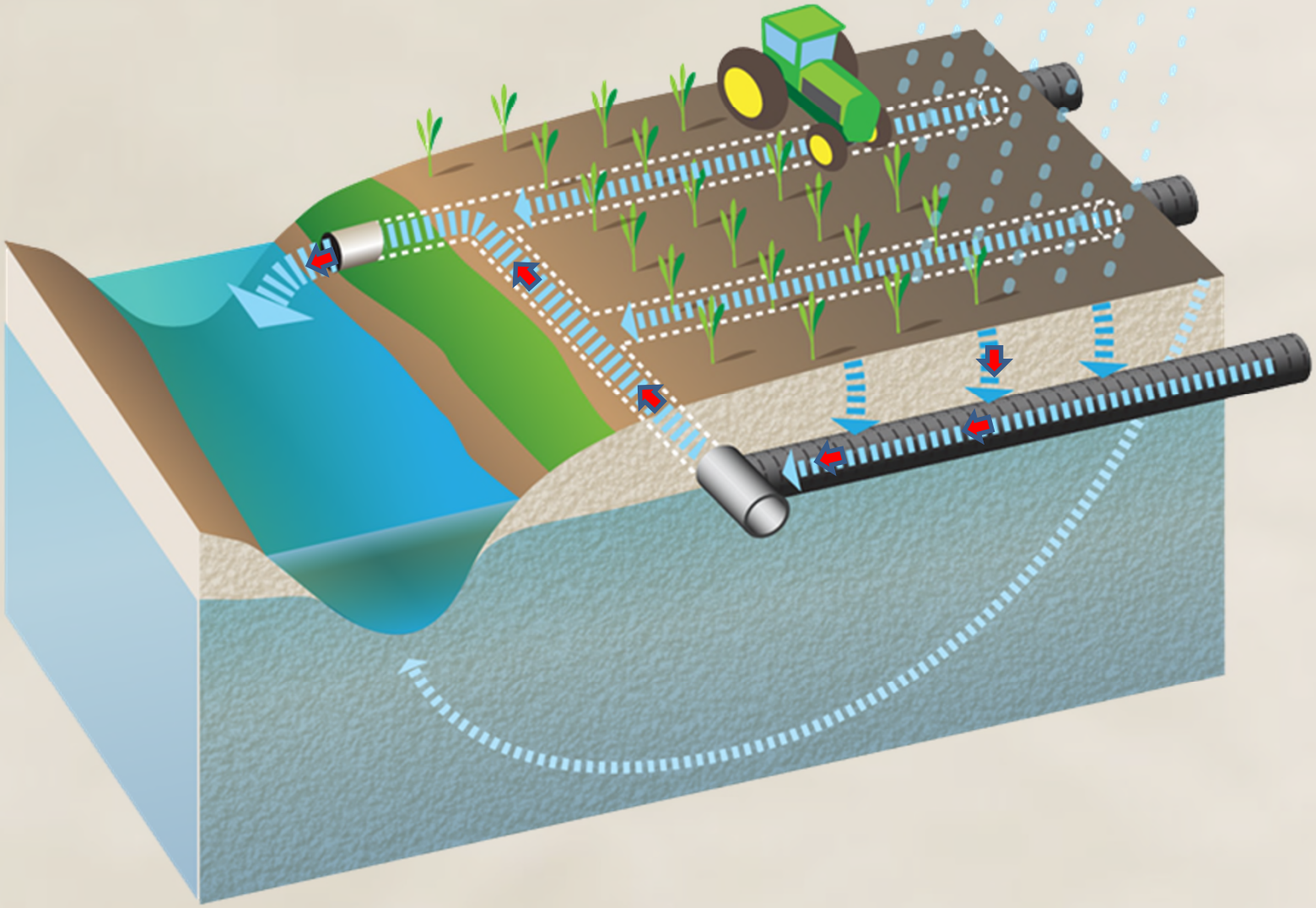
Note: Do not equate with sources to waters



Cropland groundwater source/pathway



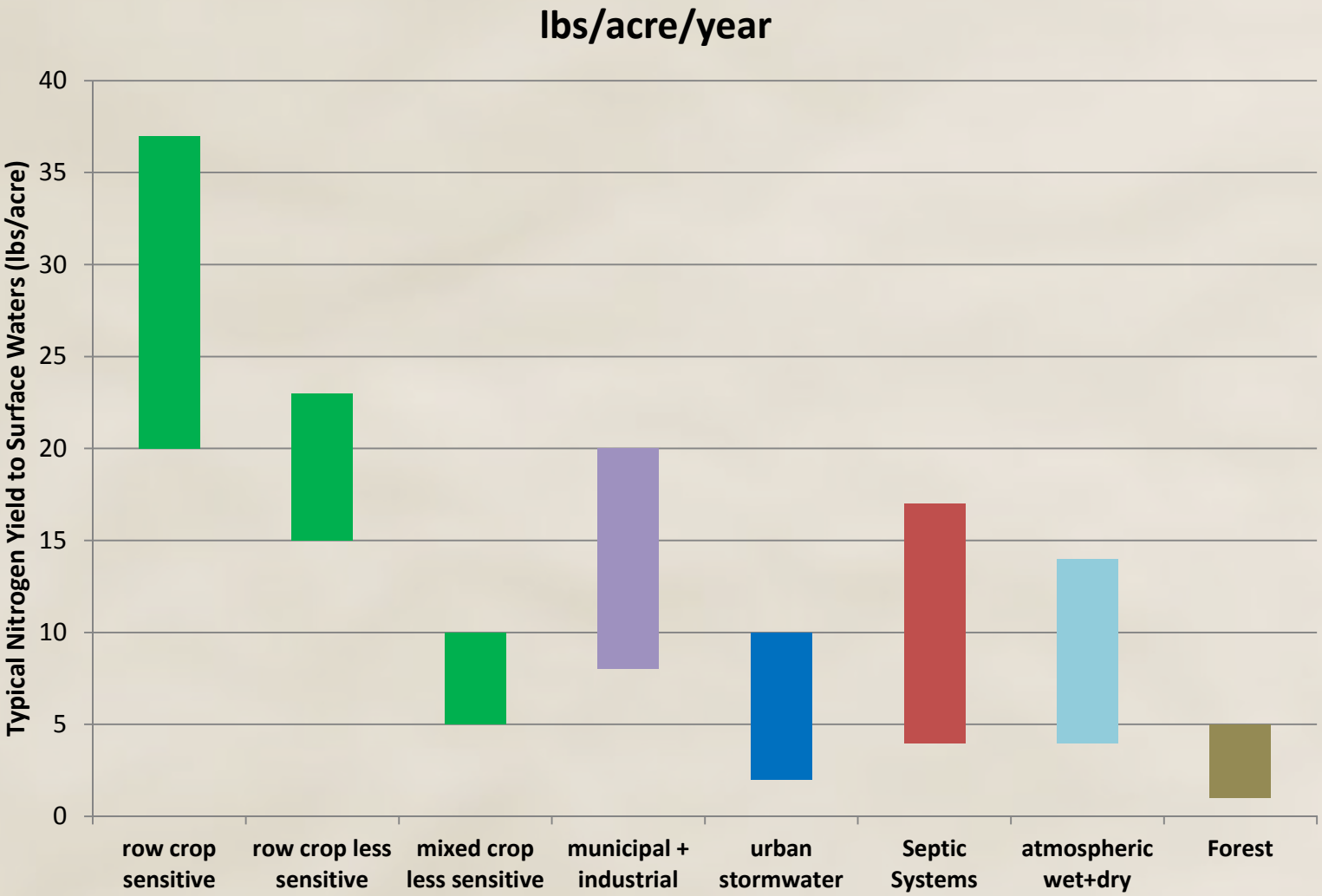
Cropland Tile Drainage Source



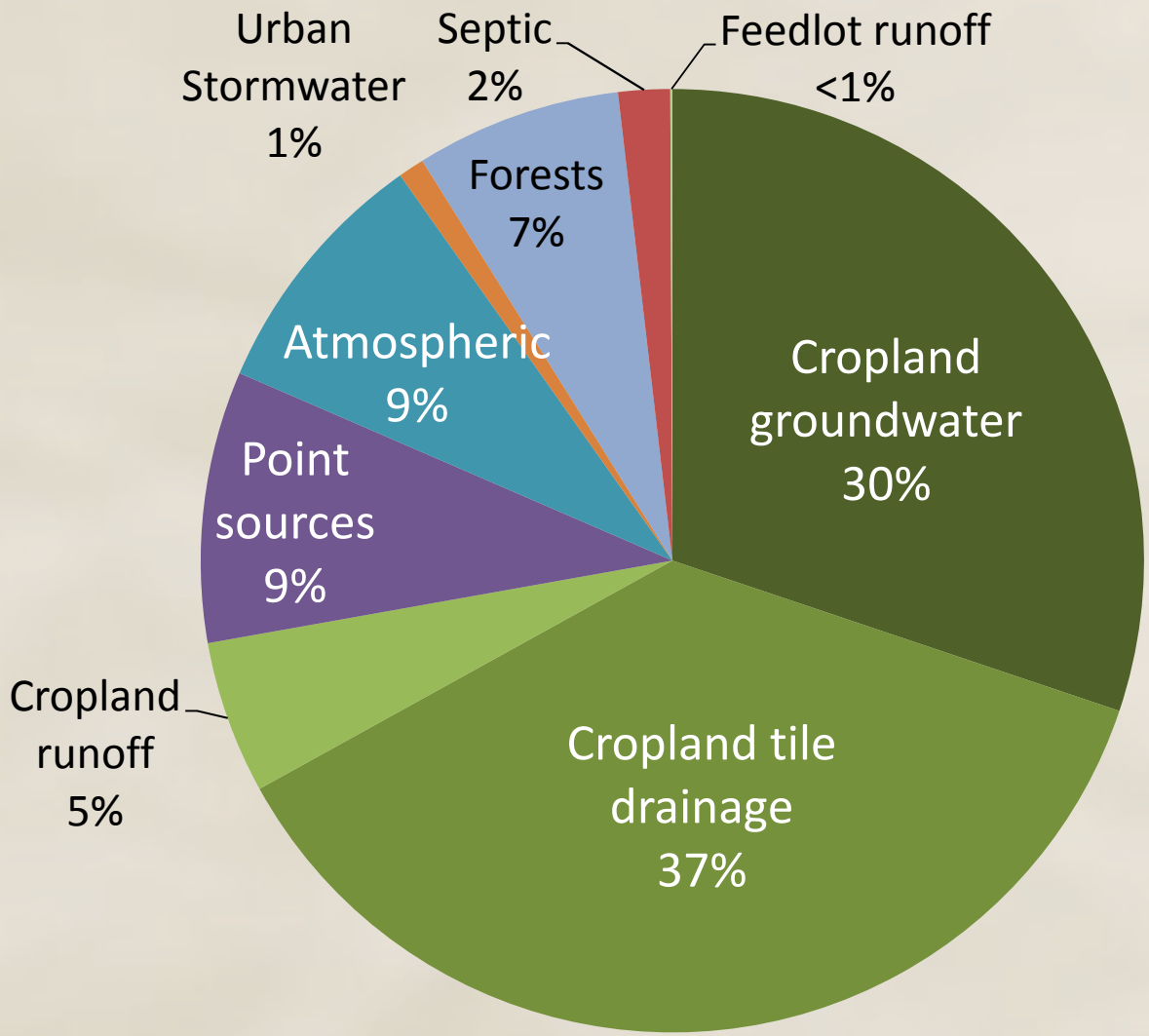
Nitrogen sources to surface waters - assessment methods

- **Cropland** – field monitoring results extrapolated to larger scales with GIS
  - 3 pathways – runoff, tile drainage, leaching to groundwater
  - Varied by soil, climate, crops, tile drainage, geology, fertilizer, manure
- **Wastewater Point Sources** – NPDES permit records
- **Urban runoff/leaching** – N yield coefficient based on urban/suburban subwatershed monitoring & literature
- **Forest** – N yield coefficient based on literature review
- **Atmospheric deposition** – CMAQ model
- **Septic systems** – monitoring and literature reviews
  - Coefficients for groundwater and surface discharge
- **Feedlot runoff** – MinnFARM model

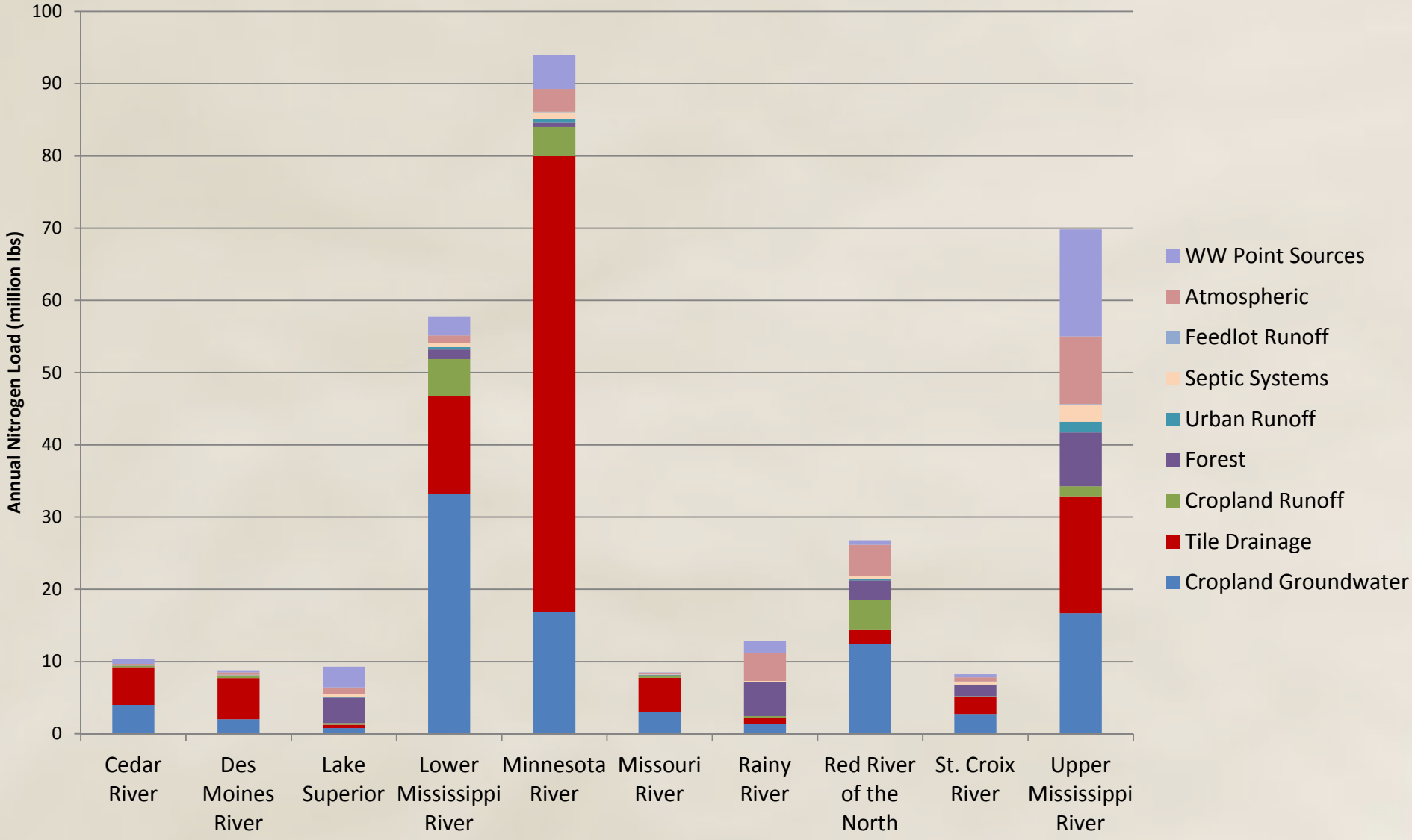
Nitrogen yield to surface waters



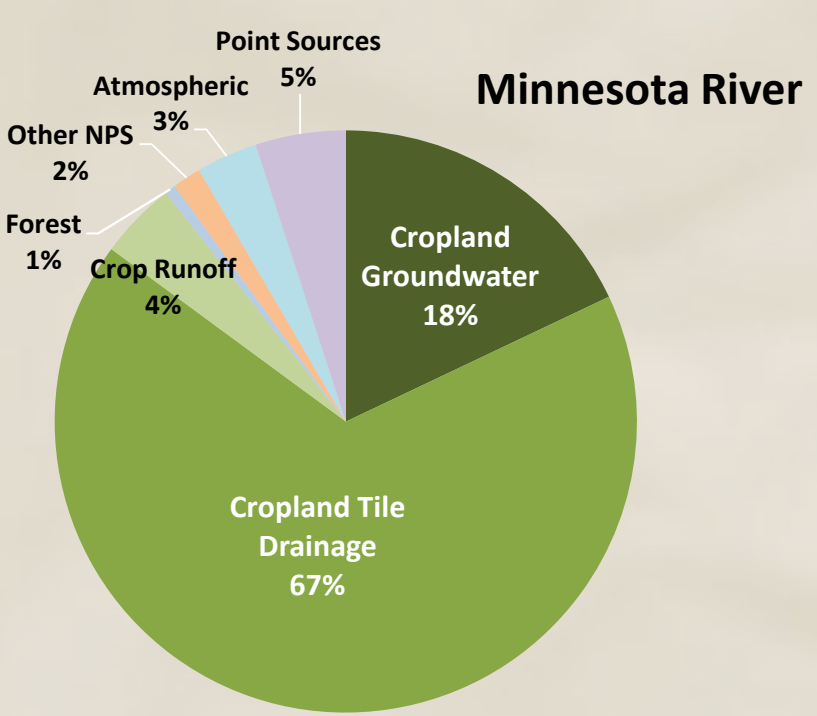
Statewide nitrogen sources to surface waters

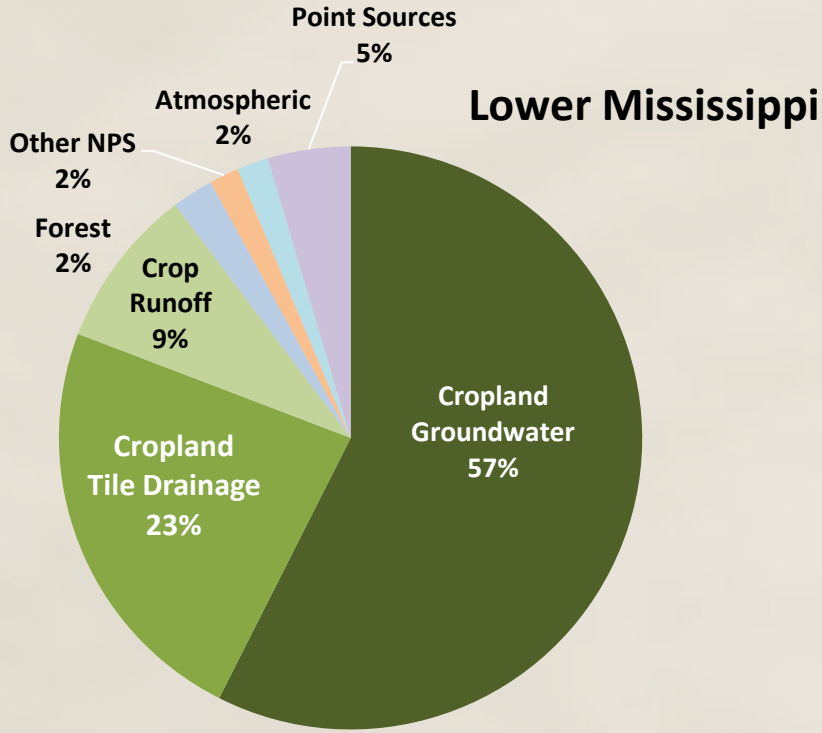


Nitrogen sources to surface waters

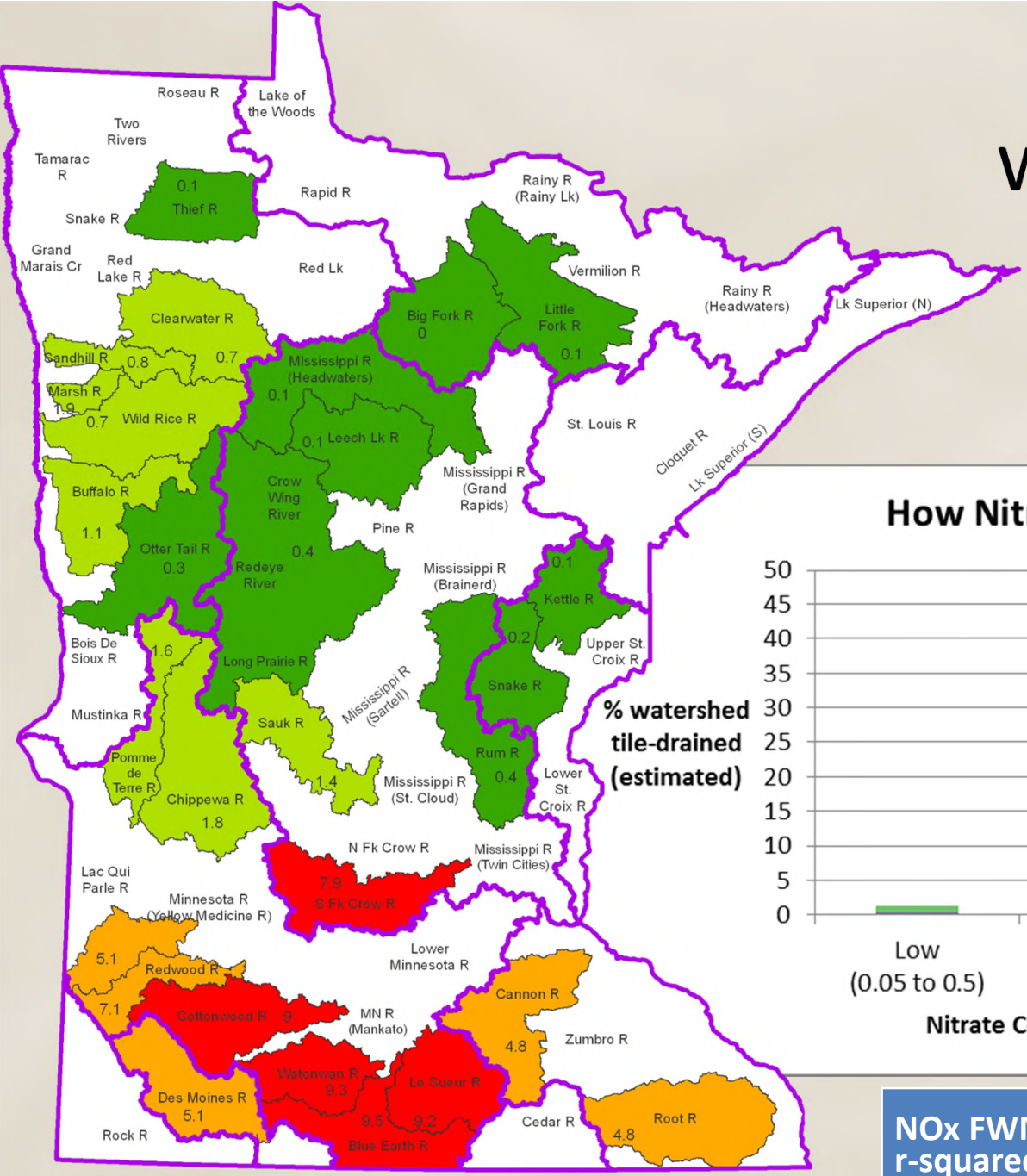


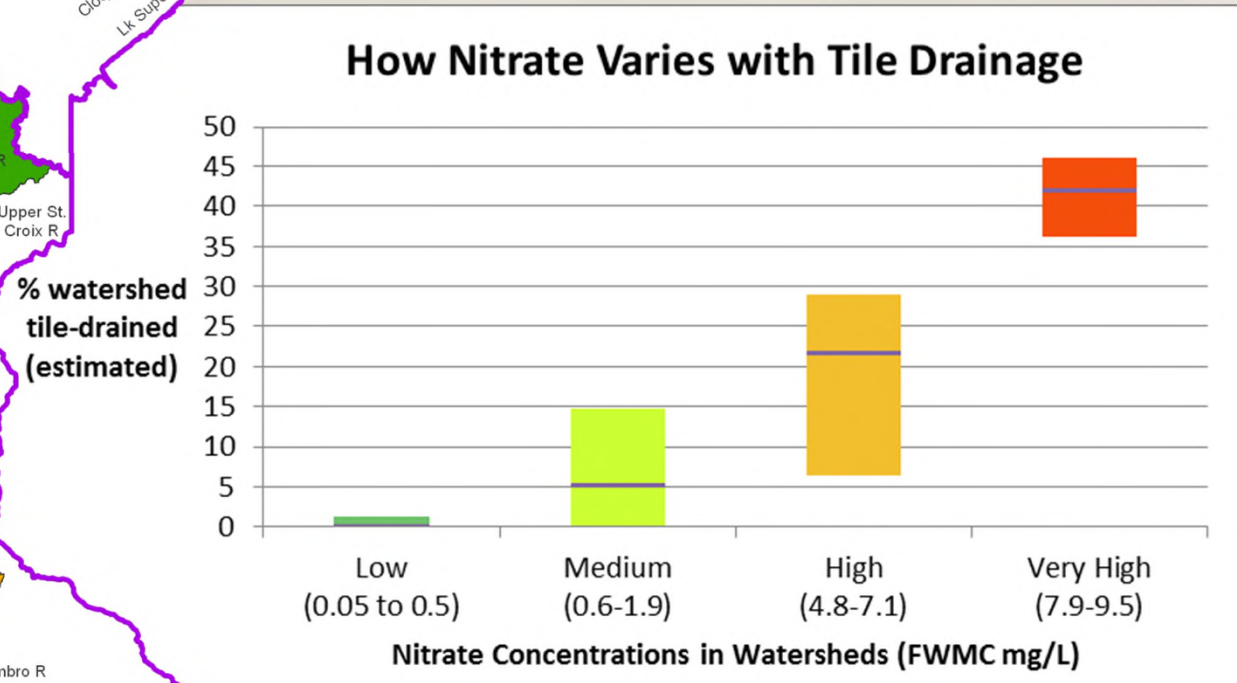
Nitrogen source differences between basins





Highest nitrate watersheds have the most row crops and tiling

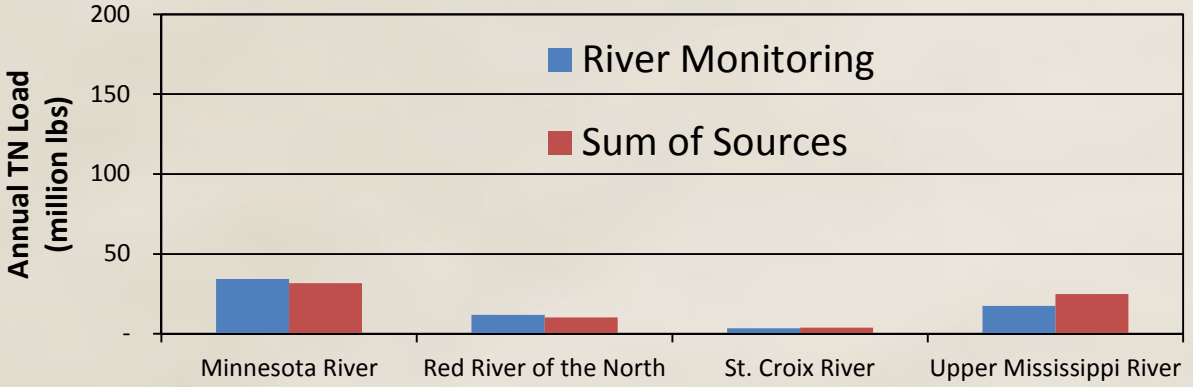




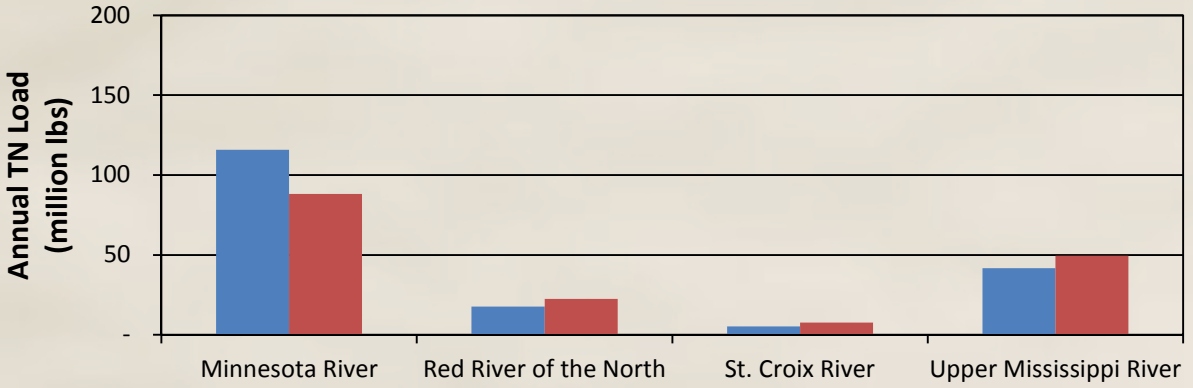
NOx FWMC = 2.98 + 2.98 TDRC + 0.66 SGRC
r-squared 0.96

Comparing cumulative source loads with monitoring

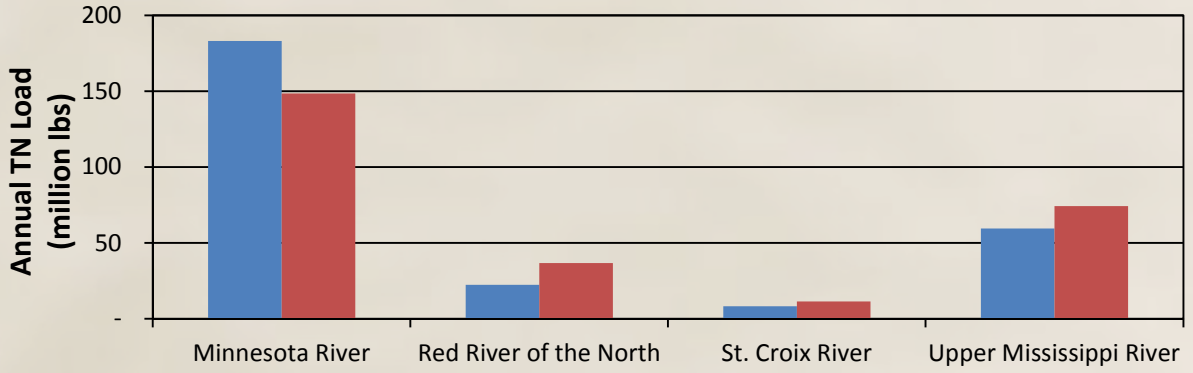
Dry year



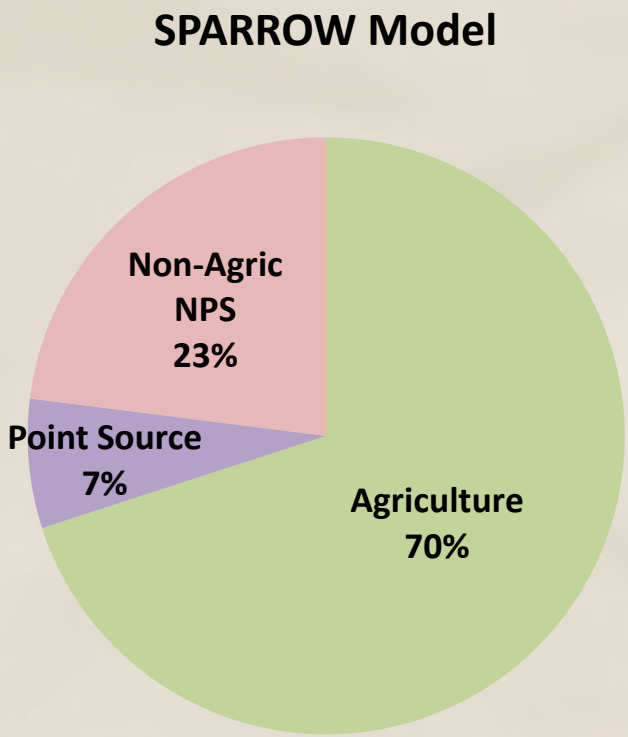
Ave. year

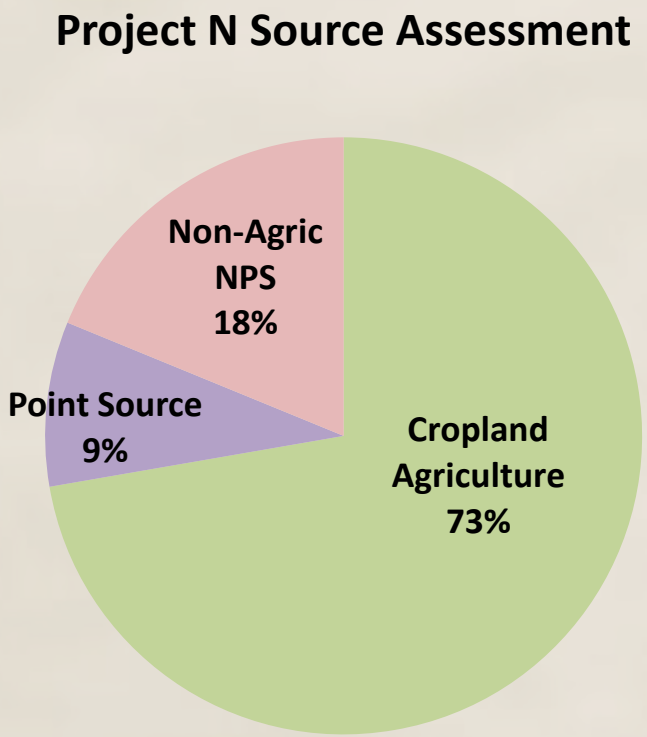


Wet year



SPARROW N sources similar to N source assessment



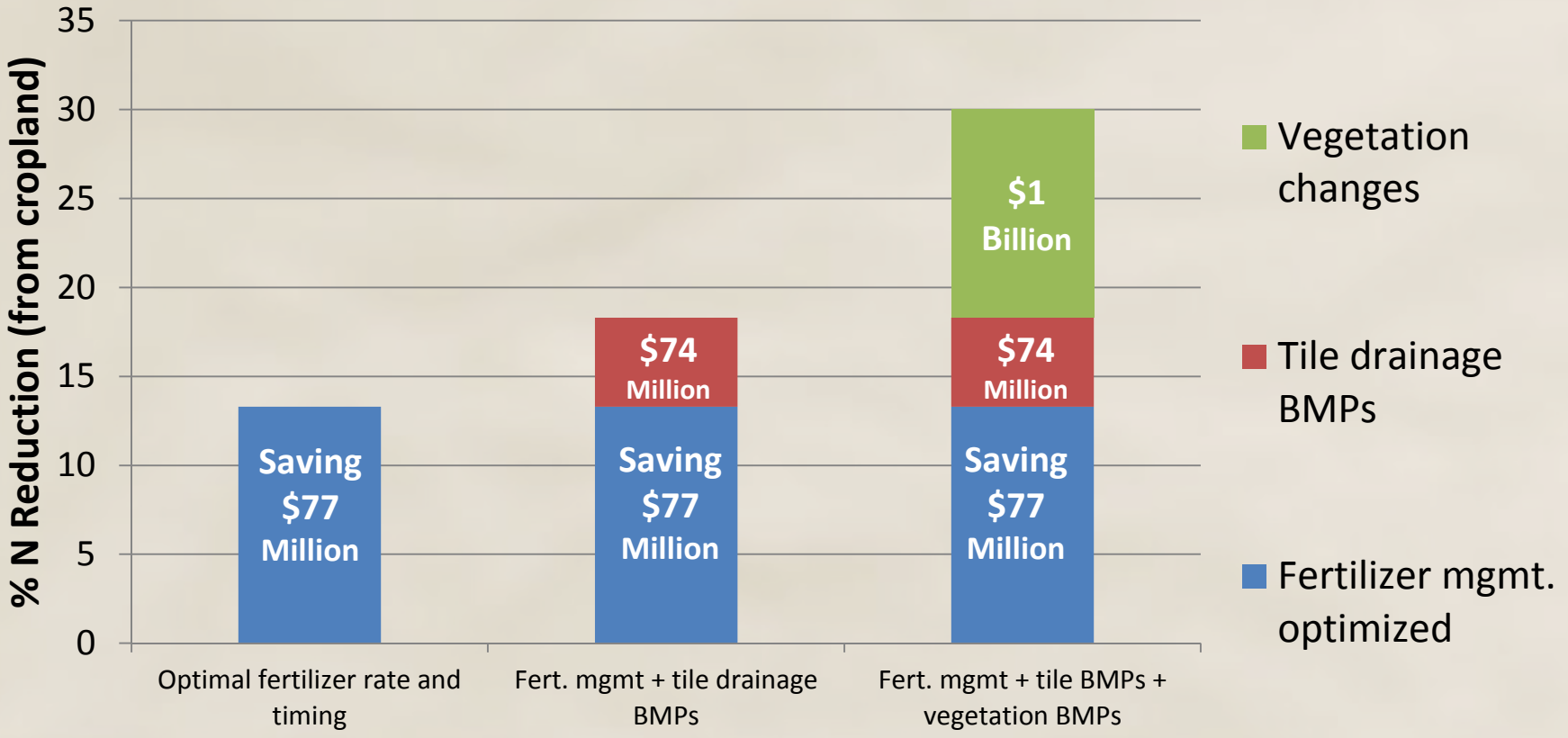


HSPF model nonpoint inorganic N sources - similar to N source assessment

Minnesota River Basin

Land use	HSPF	Project N source Assessment
Cropland	96.6%	97.6%
Urban stormwater	2.1%	0.7%
Barnyard runoff	0.19%	0.06%
Forest	0.14%	0.7%
Other	0.97%	0.94
Total	100%	100%

Reducing cropland nitrogen losses to surface waters statewide



Cost estimates subject to change with fluctuating markets

In Conclusion

1

High nitrate in Southern Minnesota –
Particularly in areas dominated by row crops over either tile drainage or karst geology

2

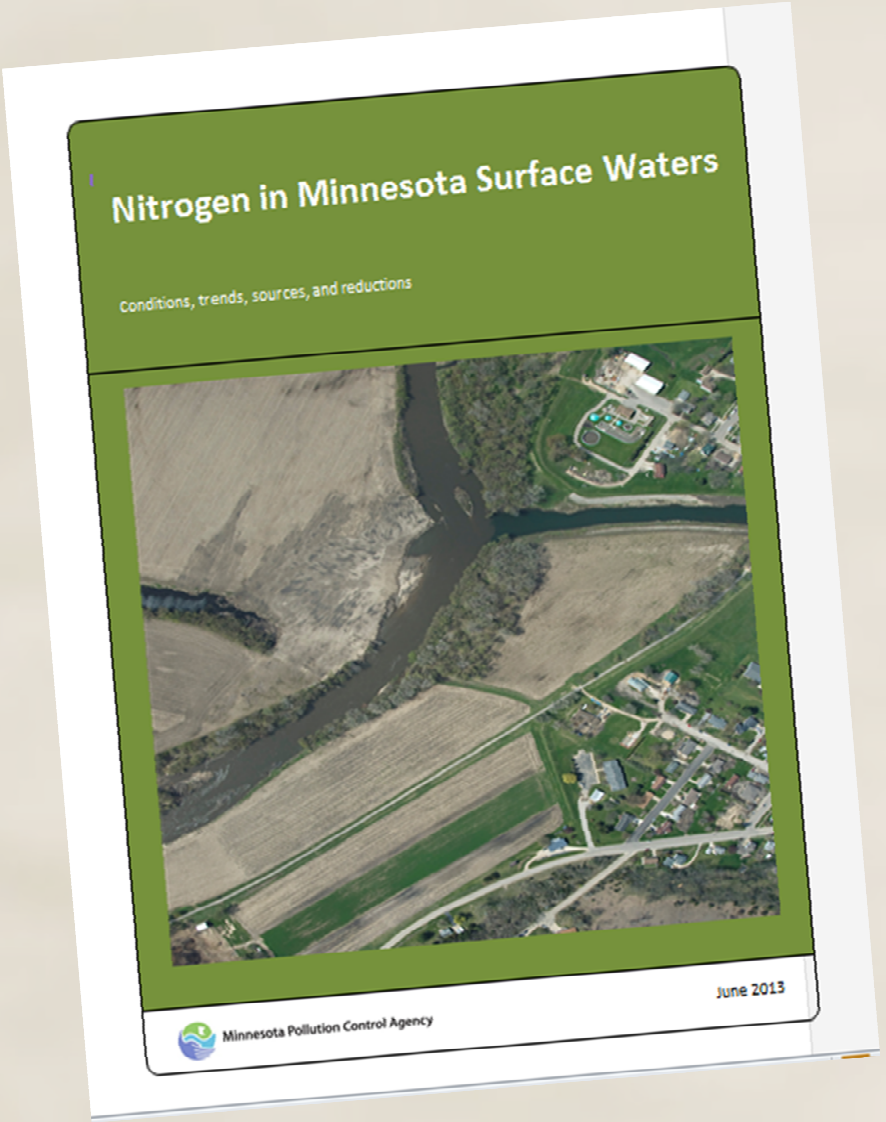
Monitoring and modeling provide generally consistent picture of N sources and pathways.
Cropland N leaching to tile lines and groundwater contributes over 70% of Mississippi River N loads.

3

Nitrogen source assessment being used for:

- State level Nutrient Reduction Strategy
- Building models for watershed N reduction planning
- Communicating needs and priorities

Questions?



www.pca.state.mn.us/6fwc9hw